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USATEA REPORT 70-7

ENGINEERING REPORT

**DEPARTMENT OF DEFENSE AMMUNITION TEST
SHIPMENT IN SEA-LAND CONTAINERS**

By

JOHN H. GRIER

April 1970



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**U. S. ARMY
TRANSPORTATION ENGINEERING AGENCY**

FORT EUSTIS, VIRGINIA

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DEPARTMENT OF DEFENSE AMMUNITION TEST SHIPMENT
IN SEA-LAND CONTAINERS

APRIL 1970

Prepared by

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ABSTRACT

The U. S. Army Transportation Engineering Agency (USATEA), Military Traffic Management and Terminal Service, Fort Eustis, Virginia, participated in the development of shipping procedures for eight different types of ammunition which were used in the initial Department of Defense (DOD) test shipment in Sea-Land shipping containers to the Republic of Vietnam (RVN). USATEA's portion of the tests consisted of providing transportation environmental test criteria, participation in the test loadings at Savanna Army Depot, observation of the loading and securing of 2.75-inch rockets and 155-millimeter shells at the Louisiana Army Ammunition Plant, and installation of mechanical shock recorders in two containers to determine shock and vibration environment during the entire move. The movement, originating at Doyline, Louisiana, encompassed highway to Port Chicago, California; terminal handling at Port Chicago; ocean voyage to Cam Ranh Bay, RVN; handling at Cam Ranh Bay; barge move to Qui Nhon; unloading at Qui Nhon; and, finally, the highway move by military convoy to a forward ammunition supply point at Pleiku.

Army personnel (USATEA and U. S. Army Materiel Command (USAMC)) inspected the loads at Port Chicago, California, and Cam Ranh Bay and Pleiku, RVN. Good shock and vibration information was obtained covering the entire move, including handling. The shipping procedures proved adequate, and no damage to the cargo was noted.

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I. INTRODUCTION

The U. S. Army Transportation Engineering Agency, Military Traffic Management and Terminal Service, Fort Eustis, Virginia, participated in the development of shipping procedures for eight different types of ammunition which were used in the initial Department of Defense test shipment in Sea-Land shipping containers to the Republic of Vietnam. USATEA's portion of the tests consisted of providing transportation environmental test criteria, participation in the test loadings at Savanna Army Depot, observation of the loading and securing of 2.75-inch rockets and 155-millimeter shells at the Louisiana Army Ammunition Plant, and installation of mechanical shock recorders in two containers to determine the shock and vibration environment during the entire move. The movement, originating at Doyline, Louisiana, encompassed highway to Port Chicago, California; terminal handling at Port Chicago; ocean voyage to Cam Ranh Bay, RVN; handling at Cam Ranh Bay; barge move to Qui Nhon; unloading at Qui Nhon; and, finally, the highway move by military convoy to a forward ammunition supply point at Pleiku. This engineering report covers the USATEA portion of the tests, including a discussion on handling of the two instrumented USATEA containers and an analysis of the transportation environment shocks experienced by them during the move from the manufacturer's plant to a forward ammunition supply point at Pleiku, RVN.

Observations made by USATEA personnel and information from USATEA data tapes combined with the accurate and timely reporting furnished by 1st Logistical Command, RVN, in their after-action report titled "Project TOCSA, Test of Containerized Shipments for Ammunition"; information furnished by USAMC personnel including a copy of the ship's log; and information and photographs furnished by the Naval Weapons Station, Concord, California, were analyzed and are presented in the preparation of this report.

In view of the excellent photographic coverage at the Naval Weapons Station, Port Chicago, California, and in order to familiarize those not directly involved in the tests with the test shipments, blocking and bracing arrangements, and terminal handling procedures, the information is presented in the following manner. First, inspection and handling of containers at Port Chicago, California, are depicted. These include photographs illustrating containers damaged en route from origin to Port Chicago, a container damaged during ship loading, blocking and bracing which required corrective measures, and loading of the containers aboard the container ship, S. S. Azalea City. Next, the detailed movements and handling experienced by two containers which were instrumented by USA-TEA are described from origin at Doyline, Louisiana, to the staging area at Port Chicago, and thence to final destination at a forward ammunition

supply point at Pleiku, RVN. Finally, an analysis of shocks consequent to transportation movements and handling at change-of-mode points is presented in detail, which includes the following:

1. Highway by truck tractor from Doyline, Louisiana, to staging area, Port Chicago, California.
2. Handling in staging area and loading aboard ship at Port Chicago.
3. Ocean voyage, Port Chicago to Cam Ranh Bay, RVN.
4. Unloading at Pier 5, Cam Ranh Bay.
5. Move by truck tractor from Pier 5 to staging area and loading aboard barge.
6. En route aboard barge from Cam Ranh Bay to Qui Nhon.
7. Unloading from barge by truck tractor at LST beach, Qui Nhon.
8. En route by truck tractor from LST beach, Qui Nhon, to a forward ammunition supply point at Pleiku.

II. OBJECTIVES

1. To observe, check, instrument, and monitor Sea-Land containers stuffed with ammunition for shipment from the manufacturer's plant in continental United States (CONUS) to a forward ammunition supply point in RVN.
2. To obtain data on the transportation environment and handling procedures for the development of transportability criteria.

III. CONCLUSIONS

1. Blocking and bracing for the 155-millimeter shells and 2.75-inch rockets were accomplished in accordance with the Savanna Army Depot drawings.
2. One pallet load in each of the containers loaded with 2.75-inch rockets was located on top of the floor-placed pallets, which was in

accordance with the drawings but not the arrangement tested at Savanna. Personnel at Pleiku had difficulty unloading the top pallets.

3. Except for minor rebanding and reblocking prior to ship loading, for two types of loads the blocking and bracing arrangements proved adequate for the move.

4. Good shock and vibration information was obtained for the entire move from origin to destination. Maximum g values were vertical, 10+; lateral, 1.3; and longitudinal, 5.0. These values indicate that one of the instrumented containers experienced rough handling. It will be shown later in the report that container number 60857 received the roughest handling.

5. The blocking and bracing arrangements used to secure the ammunition contributed to the structural strength of the containers.

6. The minimum design load of 2g's in all planes, as recommended by the U. S. Coast Guard, was exceeded during unloading from the S. S. Azalea City at Cam Ranh Bay and during the highway move from Qui Nhon to Pleiku.

IV. RECOMMENDATIONS

1. Complete a detailed analysis of all scientific data and technical field observations to establish current environmental criteria.
2. Participate in other planned test shipments of containerized ammunition.

V. GENERAL

1. Inspection and Handling of Containers at Port Chicago, California. All of the Sea-Land containers used in the shipment were new from the factory. The shipment origins and numbers of containers were as follows:

Charleston	18
Lonestar	4
Burlington	10
Doyline	30
Sierra	<u>164</u>
Total shipment	226

Two containers sustained major damage en route and the contents were reloaded; three received minor damage. Figures 1 through 5 illustrate the type and extent of damages.



Figure 1. Damaged Front Corner Posts of Container; Contents Reloaded Into Container Number 59784.



Figure 2. Damaged Floor Ribs Under Right Side of Container Number 43332; Contents Reloaded Into Container Number 59784.

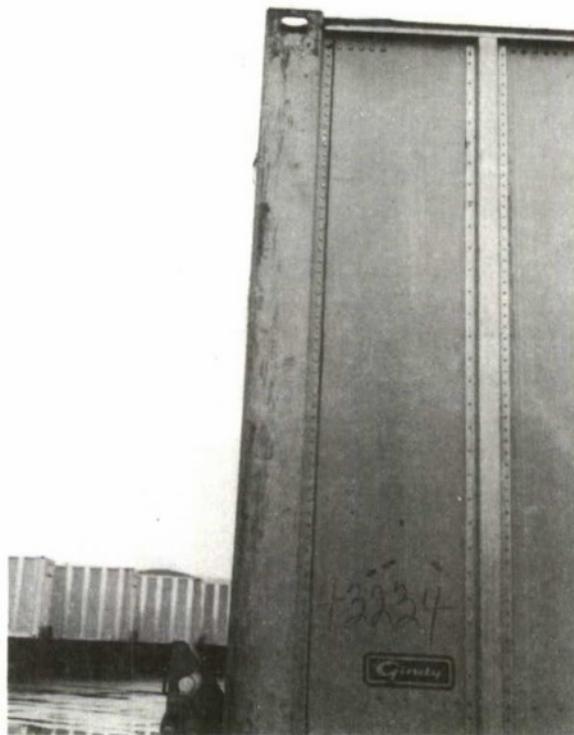


Figure 3. Top Front Bulge, Approximately 2 Inches, of Container Number 43234; Container Was Deck-Loaded.



Figure 4. Top Front Center Damaged; Container Was Deck-Loaded.

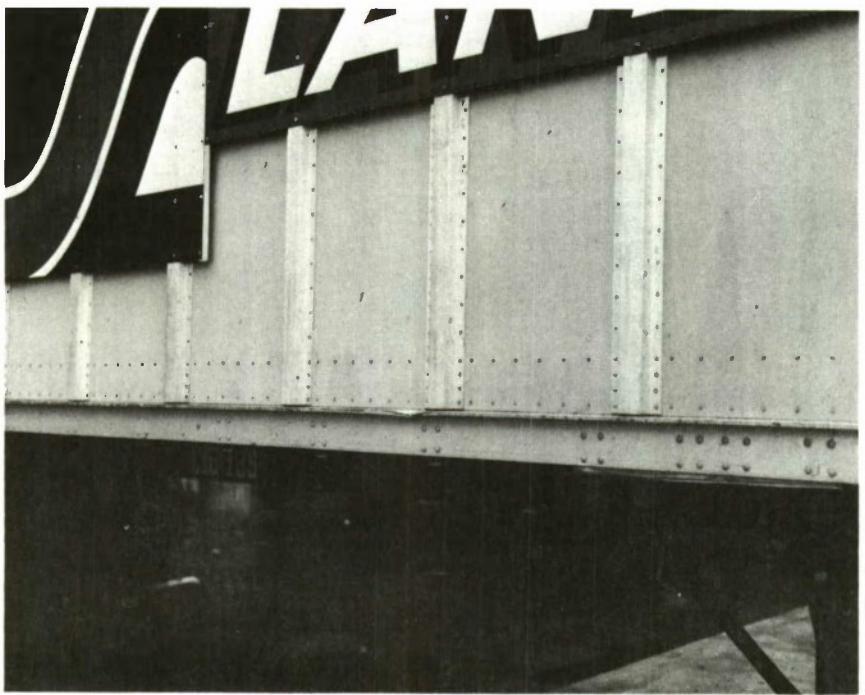


Figure 5. Minor Damage to Right Mid-Point of Frame.

One container was severely damaged during ship loading when it struck the side of the ship. Figures 6 and 7 illustrate the extent of the damage. The contents, which were not damaged, were reloaded into another container.



Figure 6. Rear View of Container Number 59135 Damaged During Loading Aboard Ship; Contents Reloaded Into Container Number 59306.



Figure 7. Front View of Container Number 59135.



Figure 8. Top Loads Frequently Required Reblocking or Banding.

Since the shipment was a portion of a DOD test and because each blocking and bracing system was new and untried, every container (226 total) was inspected by the U. S. Coast Guard prior to sealing and spotting for ship-loading. Approximately 50 loads required minor attention such as adding nails, reblocking top loads, or rebanding, particularly the 2.75-inch rockets from Doyline. Figures 8 through 14 illustrate typical blocking and bracing which required corrective measures.

Loading of the containers aboard the S. S. Azalea City is illustrated in Figures 15 through 28.



Figure 9. Container Number 59241,
Front to Rear View of
Small Arms Ammunition
Showing Blocking and
Bracing in Need of
Tightening.

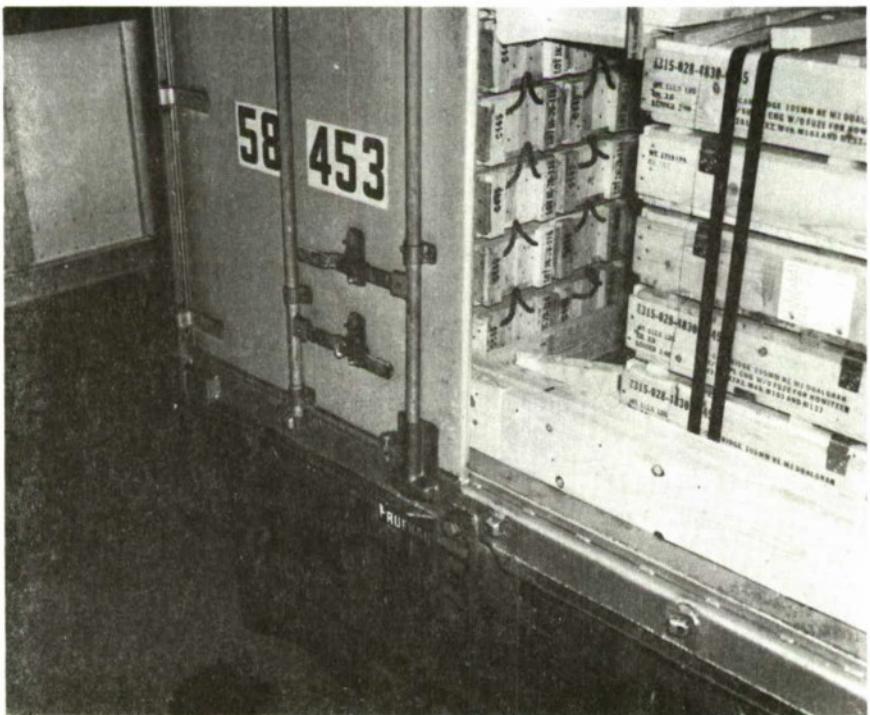


Figure 10. Container Number 58453, Bottom
2- by 8-Inch Door Brace in Need
of Tightening or Replacement.

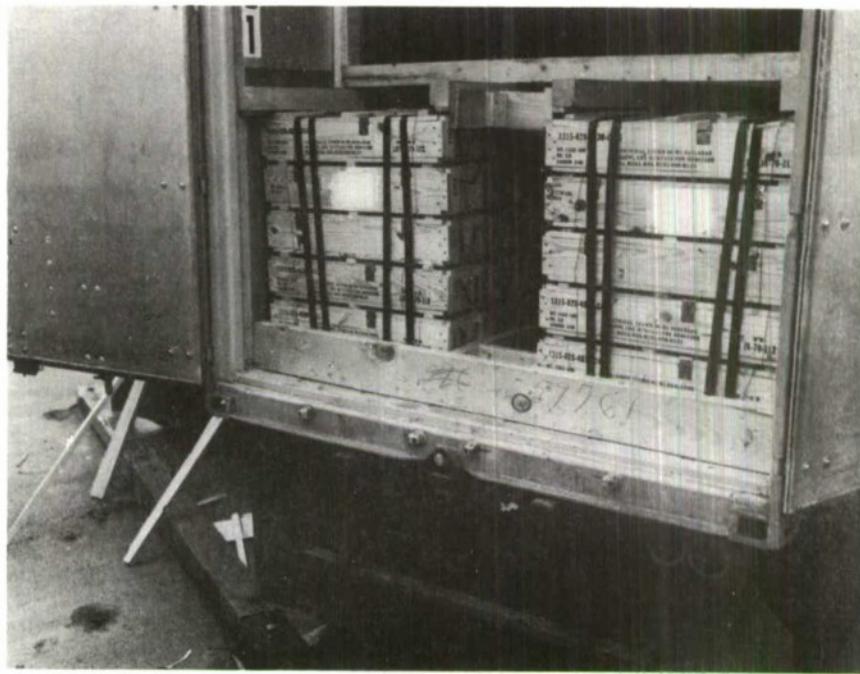


Figure 11. Container Number 59761, 4- by 4-Inch Bracing in Need of Nailing; Also, 2- by 8-Inch Brace at Door.



Figure 12. Container Number 59783, 4- by 4-Inch Bracing in Need of Nailing.

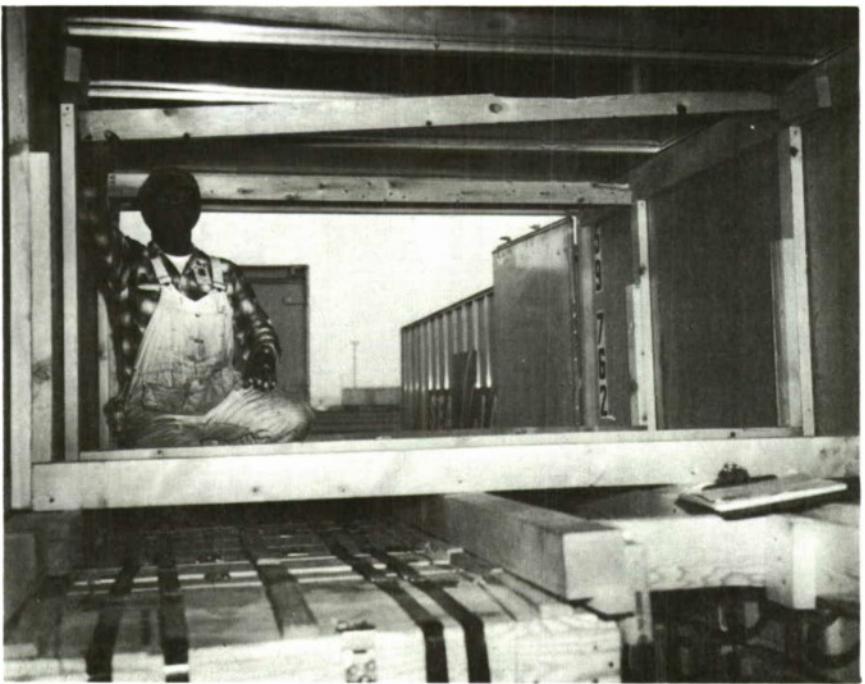


Figure 13. Container Number 59762, 2- by 4-Inch Spreader Overhead Needed To Be Replaced.



Figure 14. Container Number 59762, 2- by 6-Inch Spreader Missing.



Figure 15. Positioning Containers Alongside of Ship.



Figure 16. Aft Gantry Crane Spreader Frame Being Positioned, Using Boat Hooks for Lifting Container Aboard.



Figure 17. Aft Gantry Crane Lifting Container
Aboard; Other Containers Being Moved
Forward by Truck Tractor for Loading.



Figure 18. Container Being Lifted Aboard; Note White
Guide Line on Pier to Assist Drivers in
Positioning Containers.



Figure 19. Container Lifted Full Height; Empty Trailer Bed Moving Out of Loading Position.



Figure 20. Container Being Moved Inboard to Hatch Cell.



Figure 21. Removal of Hatch Cover by Gantry Crane.



Figure 22. Hatch Cover Being Set Aside To Open New Hatch.

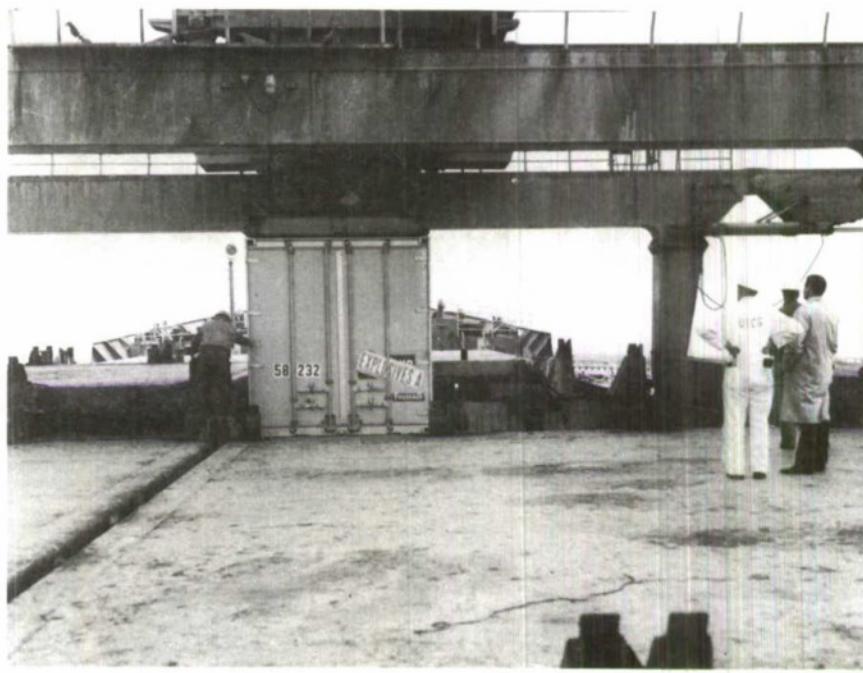


Figure 23. Container Being Lowered Into Hatch.

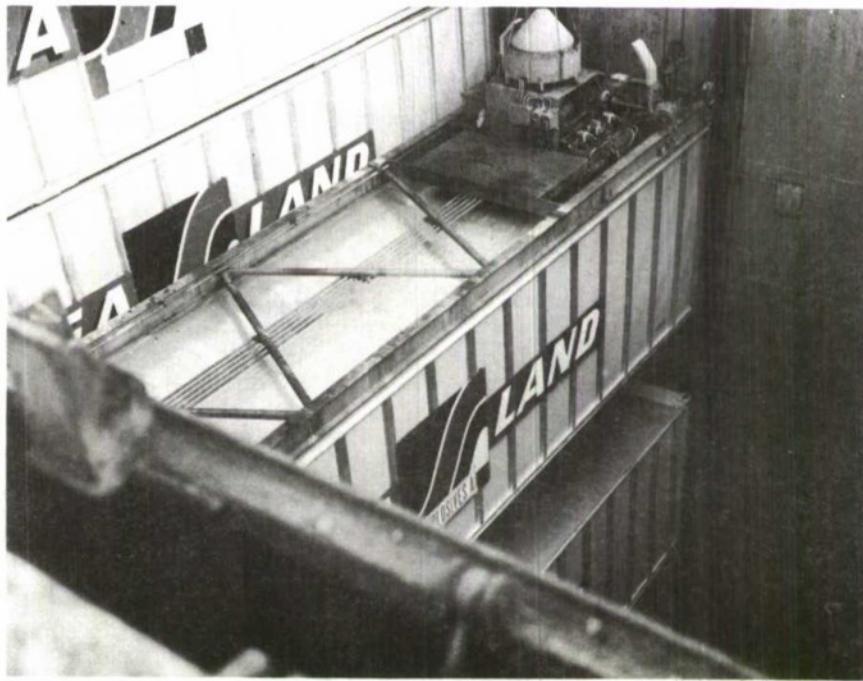


Figure 24. Container Being Lowered Into Final Position.

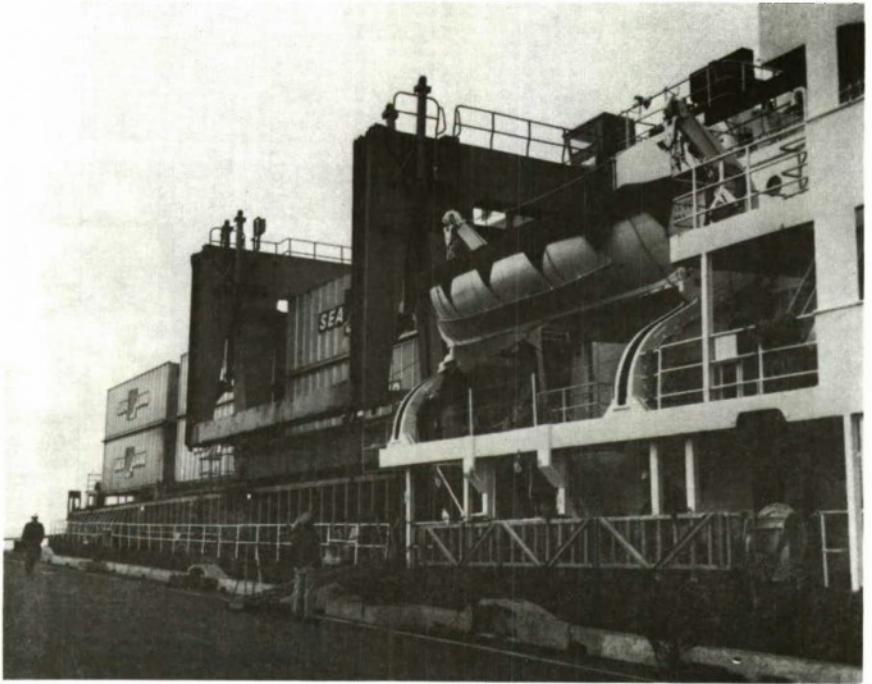


Figure 25. Gantry Crane Extensions in Down Position
After Ship Loading Completed.



Figure 26. Tiedowns on Deck-Loaded Containers at
Hatch Number 1.



Figure 27. Tiedowns on Aft-Deck-Loaded Containers.



Figure 28. Fully Loaded Ship Underway for Republic of Vietnam.

2. Highway Move of Sea-Land Container Numbers 60857 and 62272 by Truck Tractor from Doyline, Louisiana, to Staging Area, Port Chicago, California.

At Doyline (Louisiana Army Ammunition Plant), USA TEA personnel observed the loading and bracing of Sea-Land 35-foot containers with 155-millimeter shells blocked and braced in accordance with drawing number AMXSV 4167, and 2.75-inch rockets in accordance with drawing number AMXSV 4175. The weights of the shipments of 2.75-inch rockets and 155-millimeter projectiles were:

<u>Item</u>	<u>Quantity</u>	<u>Approx. Weight (lb.)</u>
<u>2.75-inch rockets</u>		
Pallet unit	37	28,535
Dunnage		1,284
Container		<u>5,485</u>
		35,304 gross weight
<u>155-millimeter projectiles</u>		
Pallet Unit	37	29,600
Dunnage		1,826
Container		<u>5,485</u>
		36,911 gross weight

Drawings of all loads and weights for all types of ammunition in the test shipment are on file at USATEA. A mechanical, three-directional accelerometer was mounted near the door opening in container number 62272, which was stuffed with 155-millimeter ammunition (Figure 29). Another mechanical accelerometer was mounted similarly in container number 60857, which was stuffed with 2.75-inch rockets (see Figure 8).



Figure 29. A Mechanical, Three-Directional Accelerometer Mounted Near Door Opening in Container Number 62272, Which Was Stuffed With 155-Millimeter Ammunition.

The routes and trucking companies for the highway trip from Doyline, Louisiana, to Port Chicago, California, were as follows: (Departure was 12 December 1969.)

<u>Container Number</u>	<u>Route</u>	<u>Truck Company</u>	<u>Arrival Time California</u>
60857	Doyline, La.	Tri-State	
	Holley, Colo.	Windecker	
	Lourviers, Colo.	Tri-State	
	Port Chicago, Calif.		0310 hours, 15 Dec 69
62272	Doyline, La.	H. J. Jefferies	
	Hugo, Okla.	Explosive Carrier	
	Boise City, Okla.	H. J. Jefferies	
	Denver, Colo.	Ashworth	
	Salt Lake City, Utah	Henry L. Young	
	Port Chicago, Calif.		1400 hours, 20 Dec 69

For general route location, see map, Figure 30. Container number 60857 was interchanged at truck terminals three times, while container number 62272 was interchanged five times, which contributed to the 5-1/2-day difference in arrival times.

3. Handling of Sea-Land Container Numbers 60857 and 62272 From Staging Area, Port Chicago, California, to Destination in RVN.

a. Container Number 60857. This container was moved from the staging area by truck tractor and loaded aboard the S.S. Azalea City on 22 December 1969 between 2030 and 2120 hours. The maximum handling-load value during this operation was 1.5g's vertical. The ship departed Port Chicago on 23 December 1969 and arrived at Pier 5, Cam Ranh Bay, RVN, on 17 January 1970. Although severe weather was encountered during the voyage, no significant g values were recorded on the accelerometer mounted inside. The container was unloaded from the S.S. Azalea City by the ship's gantry crane at Pier 5, Cam Ranh Bay on 17 January at

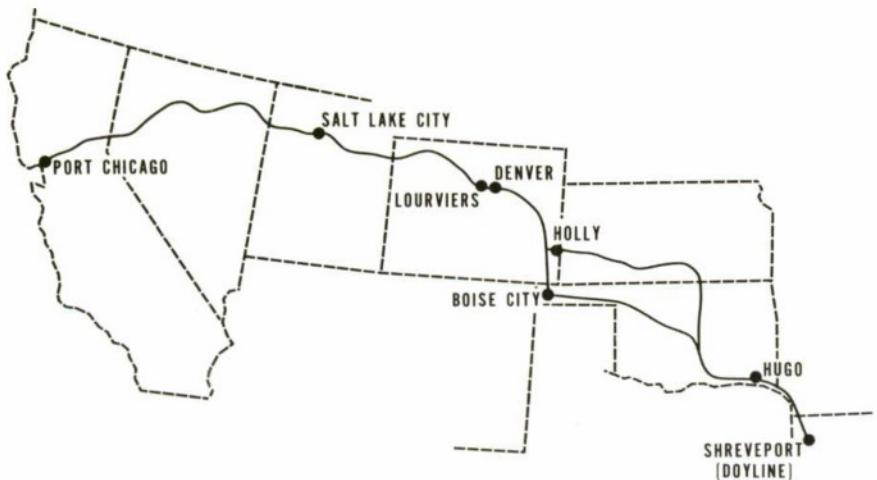


Figure 30. Routes of Shipments, Continental United States.

2245 hours. During the unloading operation a maximum g value of 4.25 in the vertical plane was recorded, with several 2 to 3g values; lateral and longitudinal values were less than 1.0g. This container was one of 22 to be transshipped on the Alaska Barge and Transport Company ramp barge number 192-2 to Qui Nhon; consequently, the container was moved from the pier by truck tractor (Sea-Land drivers) to a staging area 0.1 mile south of Pier 5. The container was opened and inspected; no damage was found. Following the inspection the container was backed aboard the barge by Sea-Land drivers. There were no significant shocks recorded during these operations.

Loading of the barge was started at 2055 hours on 17 January and completed at 2355 hours. The containers were secured by use of stanchions and chains. Under tow by the tug Seminole, the barge departed for Qui Nhon at 0005 hours on 18 January and arrived at 1829 hours. Moderate-to-heavy seas were experienced on the 147-mile voyage. A maximum vertical shock of 0.9g was recorded, with several shocks of 0.5g. Inspection of the containers at Qui Nhon prior to barge off-loading indicated the lashings on three containers had worked loose, and the wood blocks under the landing gear of five containers had slipped from under the trailer legs. Military M-52 tractors were used to remove the containers from the barge. Since the landing gear mechanism did not have sufficient leverage to raise the containers the required height, a D-7E dozer was used to lift the containers to a height which would allow connecting of tractor and container. During the off-loading operations, this container became disconnected from the tractor and the forward end of the container dropped 18 inches to the landing gear. Inspection of the container and cargo indicated there was no damage. Maximum g values recorded during the unloading operation were 1.9 vertical, with several over 1.0; and 2.0 longitudinal with

several over 0.5. Barge discharge commenced at 1838 hours and was completed at 2102 hours. The off-load site was an improved sand and gravel surface beach.

The container was moved by military convoy using M-52 tractors. The convoy departed LST beach, Qui Nhon, 0650 hours, 19 January, and arrived at An Khe 1145 hours (see map, Figure 31, with description of road). During this portion of the trip a maximum vertical shock of 6.2g's was recorded. Several values over 2.0g's and many in the 1 to 2g's range were recorded. Maximum lateral and longitudinal values were 1.0g. The convoy was halted at Bridge 11, QL19 for 2 hours because of low visibility in An Khe Pass.. Normal convoy speeds (25 miles in the hour) were maintained even though some containers had up to 24 short tons of cargo. The convoy (15 containers) arrived at Pleiku without incident at 1435 hours on 19 January. During this portion of the highway trip the maximum recorded shocks of 10+g's vertical, 1.3g's lateral, and 5.0g's longitudinal occurred. Several vertical shocks over 4g's, with numerous 2 to 3g's; several lateral shocks over 1.0g; and several longitudinal shocks over 3.0g's were experienced. Unstuffing of the container was started at 0200 hours on 20 January and completed at 0229 hours.

Vessel characteristics of the S.S. Azalea City, AB&T barge 192-2, and tug Seminole are given in Appendix I.

b. Container Number 62272. This container was moved from the staging area by truck tractor and loaded aboard the S.S. Azalea City on 22 December 1969 between 1610 and 1640 hours. The maximum handling-load value during this operation was 1.6g's vertical. The ship departed Port Chicago on 23 December 1969 and arrived at Pier 5, Cam Ranh Bay, RVN, on 17 January 1970. Although severe weather was encountered during the voyage, no significant g values were recorded on the accelerometer mounted inside. The container was unloaded from the ship by the ship's gantry crane at Pier 5, Cam Ranh Bay on 18 January and moved by truck tractor to Ammunition Area Charlie, a distance of 1.9 miles. During this operation maximum vertical g's of 1.5, with 0.2g lateral, and 0.5g longitudinal were recorded. The container was unstuffed between 1317 and 1343 hours, 18 January.

VI. ANALYSIS OF SHOCK DATA

1. Highway by truck tractor from Doyline, Louisiana, to Staging Area, Port Chicago, California.

Analysis of the data from the recorder in container number 60857 revealed that the maximum shock values were 1.0g longitudinal, 1.0g lateral, and

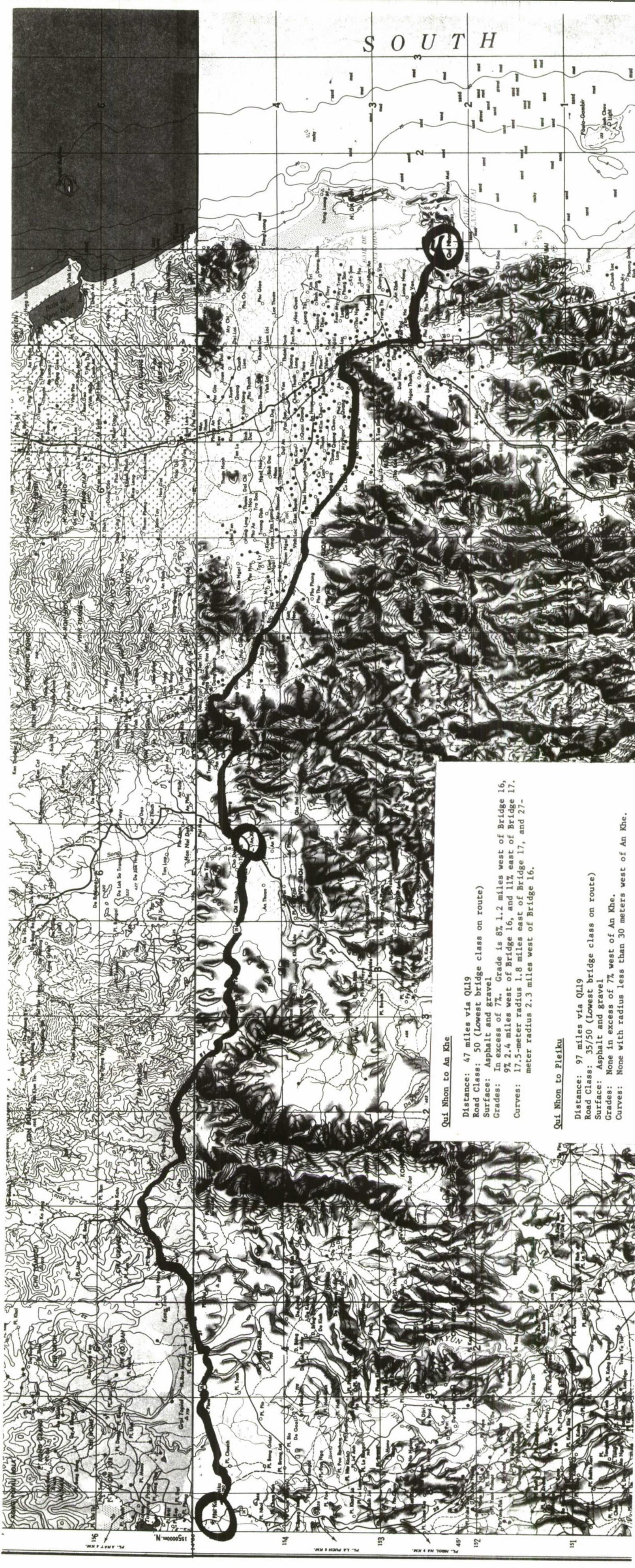


Figure 31. Route of Convoy Over Road QL19 From Qui Nhon to Pleiku, Republic of Vietnam.

2.6g's vertical. Most of the shocks both longitudinally and laterally were less than 0.5g. Vertically, numerous shocks in the 1.0 to 2.0g's range were recorded. See Table I for a detailed analysis, and Figure 32 for curves showing comparative shock distribution during the trip from Louisiana to California. The data indicate that the cargo was not subjected to rough handling.

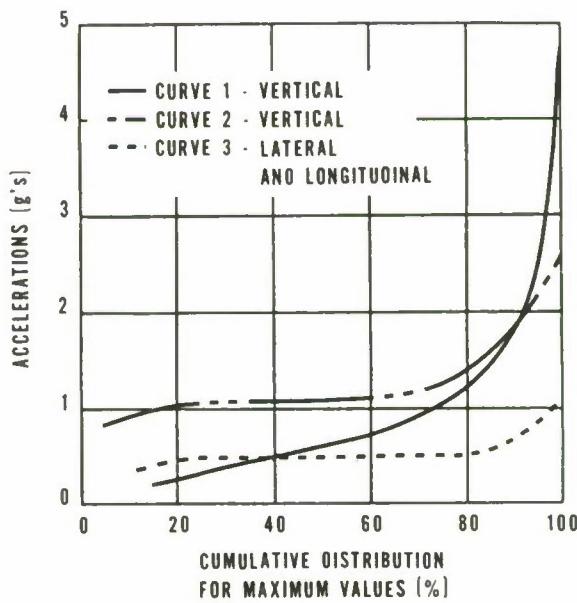


Figure 32. Comparative Cumulative Distribution Curves.

CURVE 1 - HIGHWAY MOVEMENT, 15-TON NUCLEAR CASK,
WILMINGTON, DELAWARE, TO ALBUQUERQUE,
NEW MEXICO.

CURVES 2 AND 3 - HIGHWAY MOVEMENT, AMMUNITION, SHREVEPORT,
LOUISIANA, TO PORT CHICAGO, CALIFORNIA.

2. Handling in Staging Area and Loading Aboard Ship at Port Chicago, California.

a. Container Number 60857. The data (Table II) reveal that the container was not subjected to rough handling (maximum g values were vertical, 1.5; lateral, trace; and longitudinal, 0.0) and that handling loads were less than the minimum U.S. Coast Guard design load of 2g's in all three planes.

b. Container Number 62272. The data given in Table III reveal that the container was not subjected to rough handling (maximum g values were vertical, 1.6; lateral, 0.8; and longitudinal, 0.0) and that handling loads were less than the minimum U.S. Coast Guard design load of 2g's in all planes.

TABLE I
HIGHWAY MOVEMENT BY TRUCK TRACTOR OF CONTAINER NUMBER 60857
FROM DOYLINE, LOUISIANA, TO STAGING AREA, PORT CHICAGO, CALIFORNIA

Date	Hour	Maximum g			Action
		Vertical	Lateral	Longitudinal	
11 Dec 69	1240				Recorder set.
12 Dec 69	1140				Start of trip.
		0.5	Less than 0.5	0.0	
12 Dec 69	1235				Stopped.
12 Dec 69	1350				Started.
		1.8	1.0	0.5	
12 Dec 69	1445				Stopped.
12 Dec 69	1555				Started.
		2.4	0.5	1.0	Vert. - Numerous shocks between 1.0 and 2.0g's.
12 Dec 69	1955				Stopped.
12 Dec 69	2035				Started.
		2.0	Less than 0.5	Less than 0.5	Vert. - Numerous shocks between 1.0 and 2.0g's.
12 Dec 69	2325				Stopped.
13 Dec 69	0125				Started.
		2.6	Less than 0.5	Less than 0.5	Vert. - Several over 2.0g's, numerous 1.0 to 2.0g's.
13 Dec 69	0315				Stopped.
13 Dec 69	0345				Started.
		1.6	Less than 0.5	Less than 0.5	Vert. - Many over 1.0g.
13 Dec 69	0400				Stopped.
13 Dec 69	0425				Started.
		1.5	Less than 0.5	Less than 0.5	Vert. - Several over 1.0g.

TABLE I - cont

Maximum g					
Date	Hour	Vertical	Lateral	Longitudinal	Action
13 Dec 69	0610				Stopped.
13 Dec 69	0700				Started.
		2.0	0.6	Less than 0.5	Vert. - Numerous over 1.0g.
13 Dec 69	1120				Stopped.
13 Dec 69	1150				Started.
		2.0	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
13 Dec 69	1225				Stopped.
13 Dec 69	1310				Started.
		1.0	Less than 0.5	Less than 0.5	Vert. - Several over 1.0g.
13 Dec 69	1320				Stopped.
13 Dec 69	1400				Started.
		2.0	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
13 Dec 69	1745				Stopped.
13 Dec 69	1910				Started.
		2.6	Less than 0.5	Less than 0.5	
13 Dec 69	2300				Stopped.
13 Dec 69	2330				Started.
		1.0	Less than 0.5	Less than 0.5	
14 Dec 69	0035				Stopped.
14 Dec 69	0125				Started.
		1.5	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
14 Dec 69	0245				Stopped.
14 Dec 69	0330				Started.

TABLE I - cont

Date	Hour	Maximum g			Action
		Vertical	Lateral	Longitudinal	
		2.0	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
14 Dec 69	0650				Stopped.
14 Dec 69	0800				Started.
		1.9	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
14 Dec 69	1500				Stopped.
14 Dec 69	1630				Started.
		2.0	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
14 Dec 69	1940				Stopped.
14 Dec 69	2025				Started.
		1.6	Less than 0.5	Less than 0.5	Vert. - Several over 1.0g.
14 Dec 69	2120				Stopped.
14 Dec 69	2210				Started.
		1.8	Less than 0.5	Less than 0.5	
14 Dec 69	2400				Stopped.
15 Dec 69	0025				Started.
		1.8	Less than 0.5	Less than 0.5	Vert. - Numerous over 1.0g.
15 Dec 69	0500 (EST) = 0300 (PST)				Stopped. End.

Container number 60857 arrived Port Chicago at 0310 hours on 15 December 1969.

(Checks - 2-hour time difference, Central to Pacific Standard Time, days check on tape.)

MAXIMUM VALUES FOR TRIP

1.0g longitudinal

1.0g lateral

2.6g's vertical

TABLE II
HANDLING AND MOVEMENT OF SEA-LAND CONTAINER NUMBER 60857 FROM PORT CHICAGO,
CALIFORNIA, TO PLEIKU, REPUBLIC OF VIETNAM

Date	Hour	Location	Action	Maximum g			Remarks
				Vert.	Lat.	Long.	
21 Dec 69	1010	Port Chicago, Calif.	Recorder started.	--	--	--	
22 Dec 69	2030-2120	Port Chicago, Calif.	Handling in staging area by truck tractor, loading aboard ship S.S. Azalea City.	1.5	Trace	0.0	
23 Dec 69 to 17 Jan 70	1730 0900	Pacific Ocean South China Sea	En route aboard ship.	0.0	0.0	0.0	
17 Jan 70	2245	Cam Ranh Bay, RVN	Container unloaded from ship.	4.25	0.9	0.7	Vertical - several 2 to 3g's.
	2245-2355	Moved to staging area 0.1 mile south of Pier 5, by truck tractor, Cam Ranh Bay.	Container and load inspected (o.k.), loaded on barge AB&T #192-2 by truck tractor.	0.0	0.0	0.0	
18 Jan 70	0005-1829	South China Sea	En route aboard barge under tow by tug <u>Seminole</u> . (Moderate to rough seas encountered).	0.9	0.0	0.0	Vertical - several shocks of 0.5g. Lashings on three containers worked loose, and wood blocking slipped from under legs of five containers.
	1930-2000	Qui Nhon Port LST beach.	Unloaded by truck tractor.	1.9	Trace	2.0	Vertical - several over 1.0g. Longitudinal - several over 0.5g.
19 Jan 70	0650-0805	En route to Pleiku on Route QL19.	En route by truck tractor over asphalt and gravel-surfaced roads.	6.2	1.0	1.0	Vertical - several over 2g's, many in 1 to 2g's range. Lateral - several 0.2 to 0.3g. Longitudinal - several 0.5g.
	0805-0950	Bridge 11, QL19	Convoy halted because of low visibility in An Khe Pass.	--	--	--	
0950-1435	En route to Pleiku, Arrived 1435.	En route by truck tractor over asphalt and gravel-surfaced roads.	10.0+	1.3	5.0	Vertical - several over 4.0g's; Numerous 2 to 3g's. Lateral - several over 1.0g. Longitudinal - several over 3.0g's.	
1435-1755	Pleiku	Parked.	--	--	--		
1755-1925	Pleiku	Intermittent movements in area to final position at Ammunition Supply Point.	6.1	1.0	2.5	Vertical - several 2.0g's. Longitudinal - several 2.0g's.	
2130	Pleiku	Removal of recorder.					
20 Jan 70	0200-0229	Pleiku	Unstuffing of container.				

TABLE III
HANDLING AND MOVEMENT OF SEA-LAND CONTAINER NUMBER 62272 FROM PORT CHICAGO,
CALIFORNIA, TO CAM RANH BAY, REPUBLIC OF VIETNAM

Date	Hour	Location	Action	Maximum g		
				Vert.	Lat.	Long.
21 Dec 69	1010	Port Chicago, Calif.	Recorder Started.	--	--	--
22 Dec 69	1610-1640	Port Chicago, Calif.	Handling at staging area by truck tractor. Loading aboard ship S.S. <u>Azalea City</u> .	1.6	0.8	0.0
23 Dec 69 to 17 Jan 70	1730 0900	Pacific Ocean South China Sea	En route aboard ship.	0.0	0.0	0.0
18 Jan 70	0410-0425	Cam Ranh Bay, RVN	Unloaded from ship and moved by truck tractor to Ammunition Area Charlie, Cam Ranh Bay.	1.5	0.2	0.5
1317-1343		Charlie Area	Unstuffing of container.	--	--	--

3. Ocean Voyage, Port Chicago, California, to Cam Ranh Bay, RVN.

a. Container Number 60857. Although severe weather was encountered, particularly on 6 January, no significant shocks were recorded. Maximum conditions on 6 January were wind velocity, 55 knots; wave height, 15 feet with period, 9 seconds; and swell height, 20 feet with period, 2 seconds (reference ship's log, Appendix II). That no shocks were encountered is probably due to the position of the container, which was above deck on hatch 5, cell 46 (reference Appendix III).

b. Container Number 62272. As above, this container was located above deck on hatch 7, cell 26 (reference Appendix III).

4. Unloading at Pier 5, Cam Ranh Bay, RVN.

a. Container Number 60857. During the unloading operation maximum recorded g values were vertical, 4.25; lateral, 0.9; and longitudinal, 0.7; also, several vertical shocks in the 2 to 3g's range were recorded. The data indicate that this was the most severe handling experienced by either container during loading and unloading operations on the S. S. Azalea City, and the vertical shocks exceeded the U. S. Coast Guard recommended design minimum of 2g's.

b. Container Number 62272. During the unloading operation, maximum recorded g values were vertical, 1.5; lateral, 0.2; and longitudinal, 0.5, which were all well within the U. S. Coast Guard recommended minimum design value of 2g's in all planes. This container was moved by truck tractor to Ammunition Storage Area Charlie, Cam Ranh Bay, a distance of 1.9 miles and unstuffed, thus terminating the movement of this container.

Container Number 60857

5. Move by Truck Tractor From Pier 5 to Staging Area (0.1 mile) and Loading Aboard Barge (AB&T Number 192-2).

No significant shock data were recorded during these operations.

6. En Route Aboard Barge From Cam Ranh Bay to Qui Nhon (147 Miles). During the voyage, rough seas were encountered, as evidenced by the shock data and the fact that some lashings and blocking securing the containers became loose. The maximum vertical g was 0.9, which is relatively high for water movement. Several shocks over 0.5g were recorded. No significant lateral or longitudinal shocks were recorded.

7. Unloading From Barge by Truck Tractor at LST Beach, Qui Nhon.
Data recorded during this operation do not indicate rough handling; however, rough handling involving this container did occur. Maximum g values were vertical, 1.9; lateral, trace; and longitudinal, 2.0. During unloading, the front end of the container slipped off the truck tractor and dropped 18 inches to the landing gear. The incident was not recorded on the accelerometer since it was mounted in the rear of the container. No damage was noted.

8. En Route by Truck Tractor From LST Beach, Qui Nhon Over Asphalt and Gravel-Surfaced Roads, Route QL19, to Ammunition Supply Point at Pleiku, Final Destination.

By far, the most severe shocks experienced by this container during the entire move from Doyline, Louisiana, to destination occurred during this portion of the move. Maximum recorded g values were vertical, 10+; lateral, 1.3; and longitudinal, 5.0; with several vertical shocks over 4.0g's and numerous 2 to 3g's; several lateral shocks over 1.0g; and several longitudinal shocks over 3.0g's. These shock values are representative of the maximum values which are likely to be experienced on low type roads (reference TB 55-100, Transportability Criteria Shock and Vibration, page 7).

APPENDIX I
VESSEL CHARACTERISTICS DATA

S.S. AZALEA CITY:

Class: XAK (ex C2)
Horsepower: 7,000-8,000
No. of gantry cranes: 2
Length: 468.7'
Beam: 72.1'
Draft: 25'
Crane capacity: 27.5 LTON (each)
No. of hatches: 7
Container capacity: 226 (35' by 8' by 8-1/2')
Owner: Sea-Land, Inc.

BDL LTC JOHN U.D. PAGE:

Class: Beach, Discharge, Lighter
Horsepower: 1,200 BHP @ RPM each of 2 diesel
Displacement: 2,340 LTON
Length: 304'
Beam: 65'
Cargo capacity: 600 LTON Landing condition; 2,200 LTON ocean condition.
Rated speed: 8.5 knots
Owner: U.S. Army
Draft: Landing condition: 7' mean; ocean condition: 10'8" mean.

AB&T BARGE 192-2:

Class: Ramp
Gross net tons: 1,201
Cargo capacity: 2,233 LTON
Length: 192'
Beam: 56'
Draft: 5'
Owner: AB&T

TUG SEMINOLE:

Class: 3
Displacement: 194 gross tons
Horsepower: 3,000 twin-screw
Rates speed: 10 knots
Length: 122'
Beam: 34'
Draft: 7'
Owner: AB&T

APPENDIX II SHIP'S LOG

GMT	Position	WIND DIRECTION	SEA STATE	WAVE HGT. ^a	TEMPERATURE	Dew Point	Barometric Pressure	Comments		
PAY DATE	LAT	(true)	(true)	(true)	(true)	(true)	(true)			
1/26/2000	Lat	38°45'N	Wind 80°	SW 10' SW 10'	55°	51°	1012.0			
2/21	-	Pt Chicago, IL								
3/22	1536 PT Chicago, IL									
4/23	0855 PT Chicago, IL									
4/23	1730 PT Chicago, IL									
4/23	2200 PT Bonita, CA (Just east of Golden Gate Bridge)-37 MILES FROM PT. CHICAGO									
4/23	2215 SAN FRANCISCO LIGHTSHIP BAK PILOT PICKUP BY PILOT BOAT GOLDEN GATE									
5/24	0000 READINGS NOT TAKEN UNTIL VESSEL APPROX 100 MILES FROM SHORE.									
5/24	1800 36°30'W 125°36'W 289°	13	230°	16	MISSING	15°	14°	Fog with squalls. Sea 12-15 ft. Pitch & roll with twist. Roll 18°-20°.		
5/25	0000 35°20'W 125°20'W 259°	12.5	200°	8	3	270°	10	Heavy pitching and rolling from high seas and swells.		
5/25	0000 35°20'W 125°20'W 250°	12.5	290°	21	MISSING	11°	9°	Blinds off. 35 kts. Reduced visibility-passing thru squalls. Pitching easily in long, heavy swell.		
5/26	0000 32°37'N 130°20'W 258°	13	260°	30	4	320°	12	Riding easily in rough NW'ly sea and long, heavy swell.		
5/26	0000 32°36'N 130°20'W 258°	13.2	260°	4	5	320°	12.5	Rolling easily in average N NW'ly swell. Occasional spray over starboard bow.		
5/26	0000 32°36'N 130°20'W 258°	12.6	360°	9	MISSING	12.5°	10°	Reduced visibility-passing thru squalls. Rolling easily in long, heavy swell.		
5/27	0000 31°40'N 130°40'W 258°	12.6	090°	10	.3	2	300°	8	0 cast, good visibility. Rolling and pitching easily in slight sea and averages heavy swell.	
5/27	0000 31°40'N 130°40'W 258°	13.9	110°	10	MISSING	090°	8	Vessel riding easily in a slight easterly sea.		
5/28	0000 30°50'N 145°30'W 258°	13.9	140°	26	6	7	110°	12° Rolling easily to moderately in rough SE'ly sea.		
5/28	0000 30°50'N 145°30'W 258°	13.2	140°	15	MISSING	140°	6	5	18.9° Rolling easily in moderate SE'ly sea and moderate SW'ly swell.	
5/29	0000 30°0'N 151°30'W 270°	13.2	140°	6	2	2	140°	7	7	22.8° 21° 2.1° Rolling moderately in a short moderate SE'ly swell.
5/29	0000 30°0'N 151°30'W 269°	13.2	050°	5	CALM	310°	10	3	17.8° 17.8° 18° 36.1° 17.2° Low confused swell. Riding easily.	
5/30	0000 30°0'N 157°30'W 270°	13.2	140°	5	3	2	290°	12	7	20.0° 15.9° 18° 30.0° 17.2° Rolling easily in long heavy NW'ly swell.
5/30	0000 30°0'N 162°30'W 269°	12.7	180°	10	MISSING	290°	5	7	14.9° 19.4° 20° 30.02° 17.2° Pitching moderately in medium NW'ly swell.	
5/31	0000 30°0'N 163°30'W 270°	12.7	050	5	3	2	320°	15	10	15.3° 18.3° 19° 30.02° 17.2° Pitching moderately in medium NW'ly swell.
6/1	0000 30°0'N 164°30'W 270°	13.1	00	00	CALM	320°	10	12	18.5° 16.1° 15° 30.02° 17.2° Pitching easily in medium NW'ly swell.	
6/1	0000 30°10'N 164°30'W 269°	13.1	020	6	.3	2	320°	15	7	17.8° 14.4° 12° 30.02° 17.2° Riding easily in average heavy NW'ly swell.
6/1	0000 30°10'N 162°30'W 269°	12.7	180°	12	MISSING	360°	5	8	18.3° 18.3° 19° 29.4° 17.2° Vessel riding easily in rough NW'ly sea. Occ spray over starboard side.	
6/1	0000 30°30'N 172°30'W 282°	12.5	160	12	MISSING	360°	5	8	18.3° 18.3° 19° 30.01° 17.2° Vessel pitching moderate to heavy in very rough NW'ly sea.	
6/1	0000 30°30'N 172°30'W 260°	12.5	310	30	10	12	360°	5	8	17.8° 14.4° 12° 30.01° 17.2° Rolling and Pitching easily in average moderate SW'ly swell.
6/1	0000 30°10'N 172°30'W 278°	12.5	310	33	8	12	310°	10	13	18.3° 18.3° 19° 30.02° 17.2° Pitching moderately in rough NW'ly sea and heavy NW'ly swell.
6/1	0000 30°10'N 172°30'W 279°	11.9	170	10	CALM	320°	5	10	17.8° 13.3° 10° 30.02° 17.2° Rolling and Pitching easily in a moderate SW'ly swell.	
6/1	0000 30°10'N 172°30'W 2712	11.9	230	21	5	3	210°	5	5	17.8° 16.1° 15° 29.9° 15.0° Riding easily in a moderate SW'ly swell.

WY DATE	HRS	Position	WIND			SEA WAVES			SWELL			WAVES			TEMPERATURE			Dew Point			Balance Sea				
			SPEED	DIR	CONVS	PEAK	HHR	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)	PERIOD	(SEC)
16 4	0000	31° 30' N / 172° 30' E	222°	13.0	070°	7	5	2	050°	5	3	20.0°	19.4°	17°	29.84	65.6°	Riding easily in low NE'ly swell.	16°	29.82	64.6°	Pitching easily in a W'ly sea and swell.	16°	29.92	55.6°	Pitching easily in moderate rough W'ly sea and moderate W'ly swell.
16 4	1200	31° 30' N / 169° 45' E	212°	13.0	270°	27	5	2	260°	5	5	14.9°	16.7°	16°	29.82	64.6°	Pitching easily in a W'ly sea and swell.	16°	29.82	64.6°	Pitching moderately in rough S'SW'ly sea and short heavy W'ly swell.	16°	29.82	64.7°	Pitching moderately in rough S'SW'ly sea and short heavy W'ly swell.
17 5	0000	32° 00' N / 166° 30' E	270°	13.7	230°	21	5	3	270°	5	7	21.0°	18.3°	18°	29.92	56.0°	Pitching moderately in rough S'SW'ly sea and short heavy W'ly swell.	16°	29.82	64.7°	Pitching heavily. Pitching heavily. Very rough W'ly sea and short heavy swell. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.82	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Sea & wind increasing. Riding easily in rough sea and moderate small, short, irregular swell. Spray over port side.
17 5	1200	31° 30' N / 163° 45' E	269°	13.7	220°	21	5	5	270°	5	10	17.8°	15.6°	14°	29.82	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.82	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.82	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.
18 6	0000	31° 30' N / 160° 30' E	266°	17.0	200°	30	6	10	250°	6	12	17.8°	16.7°	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.
18 6	1200	31° 30' N / 160° 30' E	265°	17.0	200°	30	6	10	250°	6	12	17.8°	16.7°	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.	16°	29.62	64.7°	Pitching moderately, taking spray over Stbd side in rough W'NW'ly sea. Short. Heavy squalls. Reduced speed. Pitching heavily. Heavy spray over Stbd side. Water over deck.
19 7	0000	32° 00' N / 156° 30' E	280°	9.0	270°	16	5	3	250°	6	5	10.6°	11.7°	9°	30.09	72.0°	Light squalls. Light squalls. Sea & wind increasing. Riding easily in rough sea and moderate small, short, irregular swell. Spray over port side.	16°	30.09	72.0°	Heavy squalls. Pitching and rolling in rough sea and heavy swell.	16°	30.09	72.0°	Heavy squalls. Pitching and rolling in rough sea and heavy swell.
19 7	1200	32° 00' N / 153° 45' E	280°	9.0	250°	25	5	5	260°	6	8	14.4°	13.2°	11°	29.84	64.7°	Heavy squalls. Pitching and rolling in rough sea and heavy swell.	16°	29.84	64.7°	Heavy squalls. Pitching and rolling in rough sea and heavy swell.	16°	29.84	64.7°	Heavy squalls. Pitching and rolling in rough sea and heavy swell.
20 8	0000	31° 30' N / 150° 45' E	280°	11.4	250°	21	5	3	260°	6	8	12.2°	10.0°	8°	29.94	64.7°	Occasional squalls. Pitching moderately in moderate sea and average heavy W'ly swells.	16°	29.94	64.7°	Occasional squalls. Pitching moderately in moderate sea and average heavy W'ly swells.	16°	29.94	64.7°	Occasional squalls. Pitching moderately in slight sea and avg. mod. swell.
20 8	1200	33° 30' N / 149° 30' E	280°	11.4	320°	10	3	2	320°	6	5	13.3°	12.2°	12°	29.82	72.0°	Squalls, rolling and pitching moderately in slight sea and avg. mod. swell.	16°	29.82	72.0°	Squalls, rolling and pitching moderately in slight sea and avg. mod. swell.	16°	29.82	72.0°	Squalls, rolling and pitching moderately in slight sea and avg. mod. swell.
21 9	0000	34° 00' N / 145° 30' E	280°	12.5	260°	33	6	5	290°	10	10	13.7°	8.5°	6°	29.93	64.6°	Same.	16°	29.93	64.6°	Same.	16°	29.93	64.6°	Same.
21 9	1200	34° 00' N / 144° 30' E	276°	12.5	310°	28	A1551NG M1.551NG	M1.551NG	132.0°	11.7°	11°	30.27	72.0°	Same.	16°	30.27	72.0°	Same.	16°	30.27	72.0°	Same.			
22 10	0000																								
22 10	1200																								
23 11	0000																								
23 11	1200	32° 04' N / 150° 44' E	229°	12.7	320°	16	5	5	320°	8	10	11.7°	8.3°	6°	29.94	64.7°	Riding easily in rough W'ly sea. Spray over starboard side.	16°	29.94	64.7°	Riding easily in rough W'ly sea. Spray over starboard side.	16°	29.94	64.7°	Riding easily in rough W'ly sea. Spray over starboard side.
24 12	0000	30° 40' N / 138° 30' E	260°	13.7	320°	21	5	3	330°	5	3	13.9°	9.4°	5°	30.10	72.0°	Riding easily in rough NW'ly sea. Occasional spray over starboard side.	16°	30.10	72.0°	Riding easily in rough NW'ly sea. Occasional spray over starboard side.	16°	30.10	72.0°	Riding easily in small NW'ly sea and swell.
24 12	1200	31° 30' N / 131° 30' E	226°	13.7	270°	10	5	2	260°	5	3	15.6°	11.7°	8°	30.18	72.0°	Riding easily in small NW'ly sea and swell.	16°	30.18	72.0°	Riding easily in small NW'ly sea and swell.	16°	30.18	72.0°	Riding easily in small NW'ly sea and swell.
25 13	0000	24° 00' N / 129° 30' E	220°	13.3	340°	8	M1.551NG	M1.551NG	36.0°	5	3	16.1°	12.3°	11°	30.24	64.7°	Riding easily in slight W'ly sea and short swell.	16°	30.24	64.7°	Riding easily in slight W'ly sea and short swell.	16°	30.24	64.7°	Riding easily in slight W'ly sea and short swell.
25 13	1200	24° 00' N / 129° 20' E	326°	13.3	360°	12	4	2	050°	5	5	19.4°	17.8°	17°	30.21	64.7°	Riding easily in slight E'ly sea and short swell.	16°	30.21	64.7°	Riding easily in slight E'ly sea and short swell.	16°	30.21	64.7°	Riding easily in slight E'ly sea and short swell.
26 14	0000	23° 30' N / 124° 40' E	244°	14.6	050°	14	4	3	070°	8	5	17.4°	17.4°	20°	30.11	72.0°	Light drizzle.	16°	30.11	72.0°	Light drizzle.	16°	30.11	72.0°	Light drizzle.
26 14	1200	19° 30' N / 123° 30' E	227°	14.6	050°	6						23.2°	22.2°	20°	29.93	72.0°	Riding easily in slight E'ly sea and short swell.	16°	29.93	72.0°	Riding easily in slight E'ly sea and short swell.	16°	29.93	72.0°	Riding easily in slight E'ly sea and short swell.
27 15	0000																								
27 15	1200																								
28 15	0000	17° 45' N / 118° 30' E	227°	13.9	020°	25	5	7	020°	5	8	23.2°	20.0°	19°	30.08	72.0°	Rolling heavily at time.	16°	30.08	72.0°	Rolling heavily at time.	16°	30.08	72.0°	Rolling heavily at time.
28 16	0000	15° 30' N / 116° 00' E	232°	14.4	020°	25	5	7	020°	5	7	22.8°	20.0°	19°	30.08	72.0°	Rolling moderately in rough NNE'ly sea and low swell.	16°	30.08	72.0°	Buoy disappeared from surface, 1 hour due to striking channel buoy marker.	16°	30.08	72.0°	Buoy disappeared from surface, 1 hour due to striking channel buoy marker.
28 16	1200	13° 30' N / 113° 30' E	244°	14.4	040°	20	5	7	040°	5	7	23.9°	21.0°	20°	30A3	22.8°	Rolling easily in moderate NE'ly sea and low swell.	16°	30A3	22.8°	Rolling easily in moderate NE'ly sea and low swell.	16°	30A3	22.8°	Rolling easily in moderate NE'ly sea and low swell.
29 17	0000																								
29 17	1200																								
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29 17	1200																								
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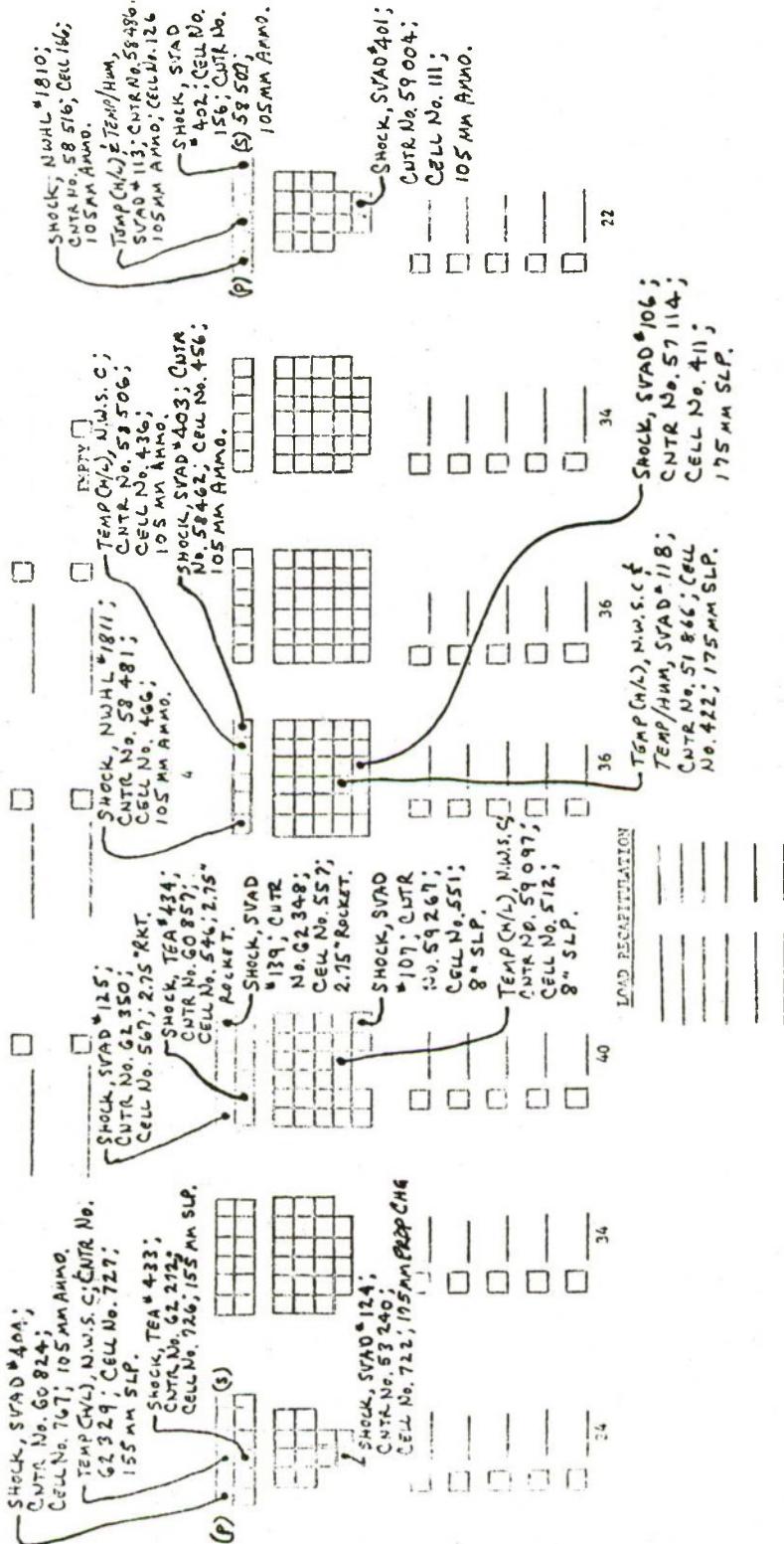
APPENDIX III
SHIP'S PLAN SHOWING INSTRUMENT LOCATION

INSTRUMENTATION DATA (12-22-69)

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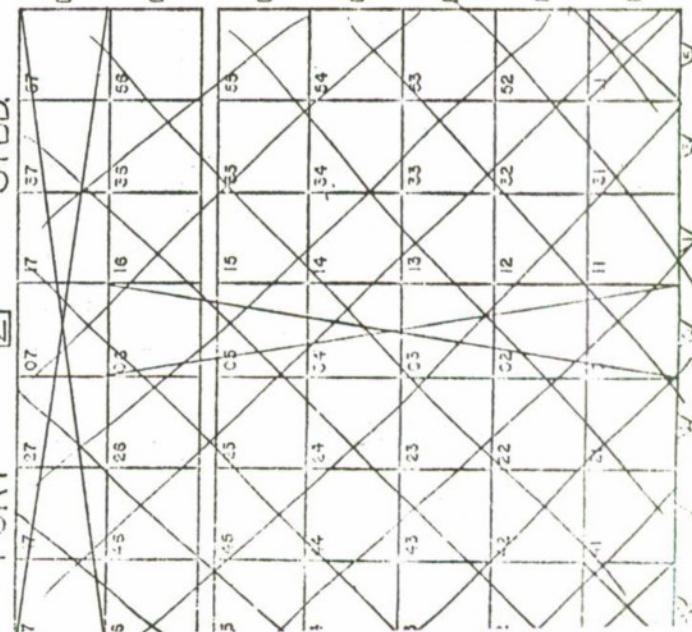
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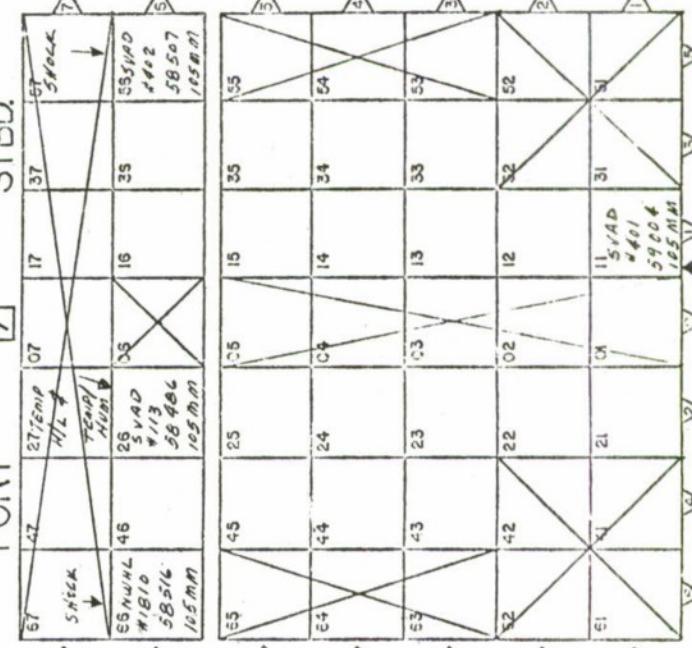
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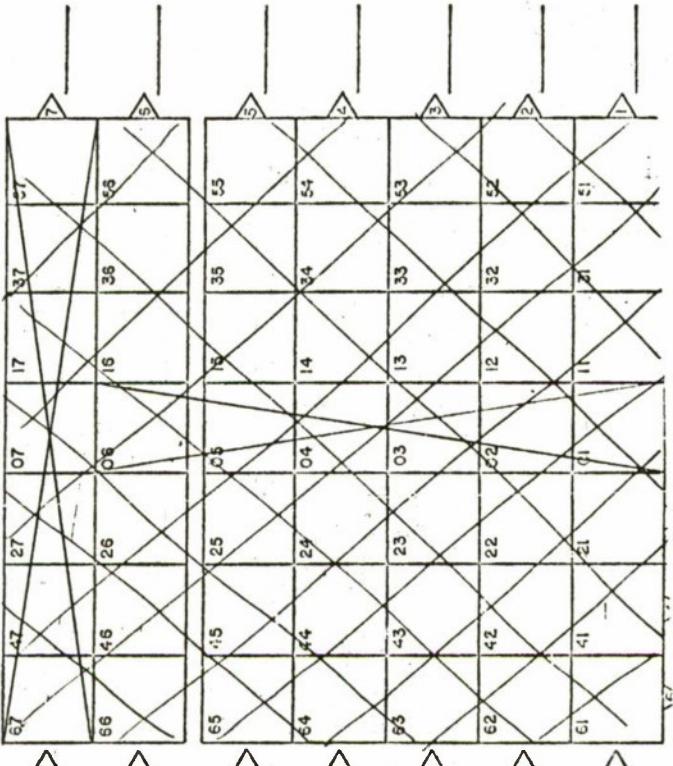
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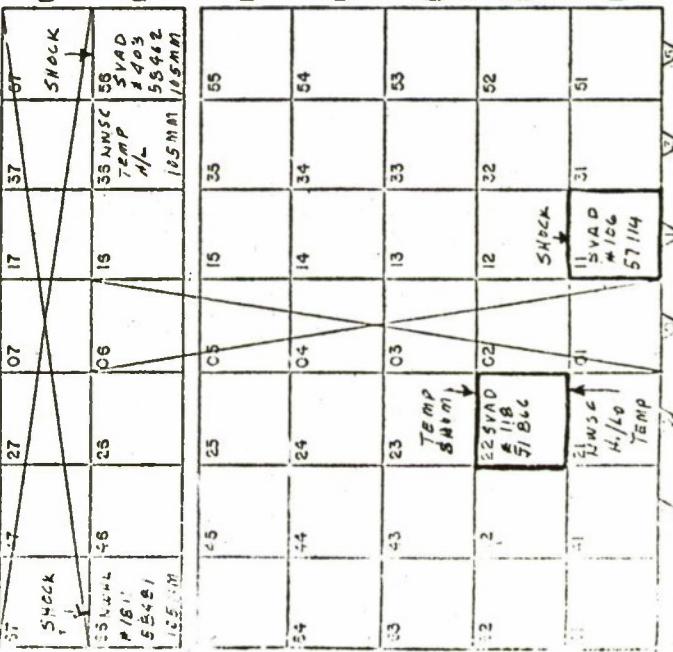
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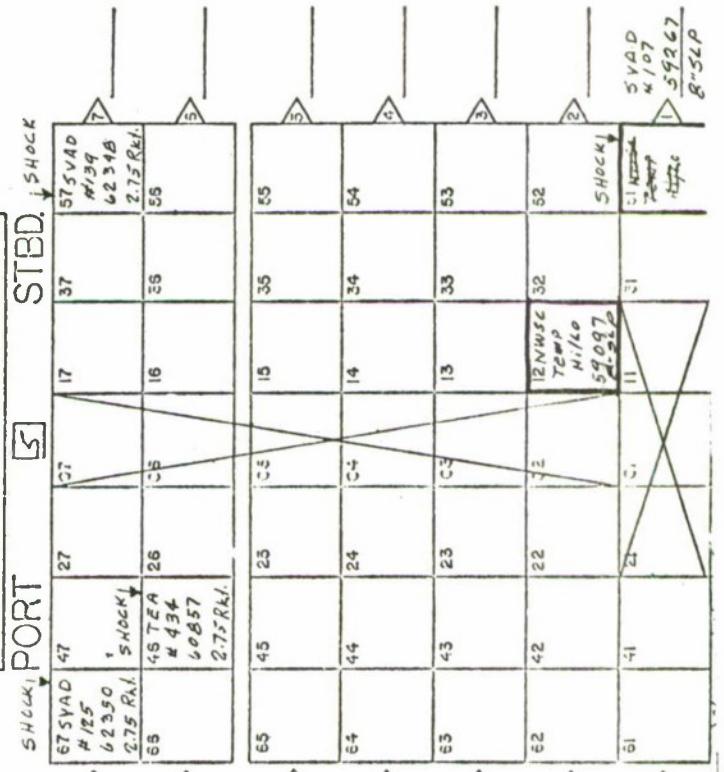
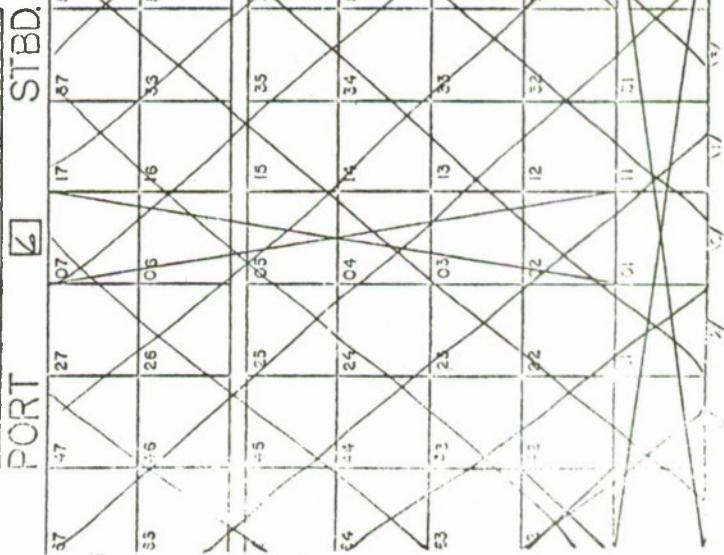
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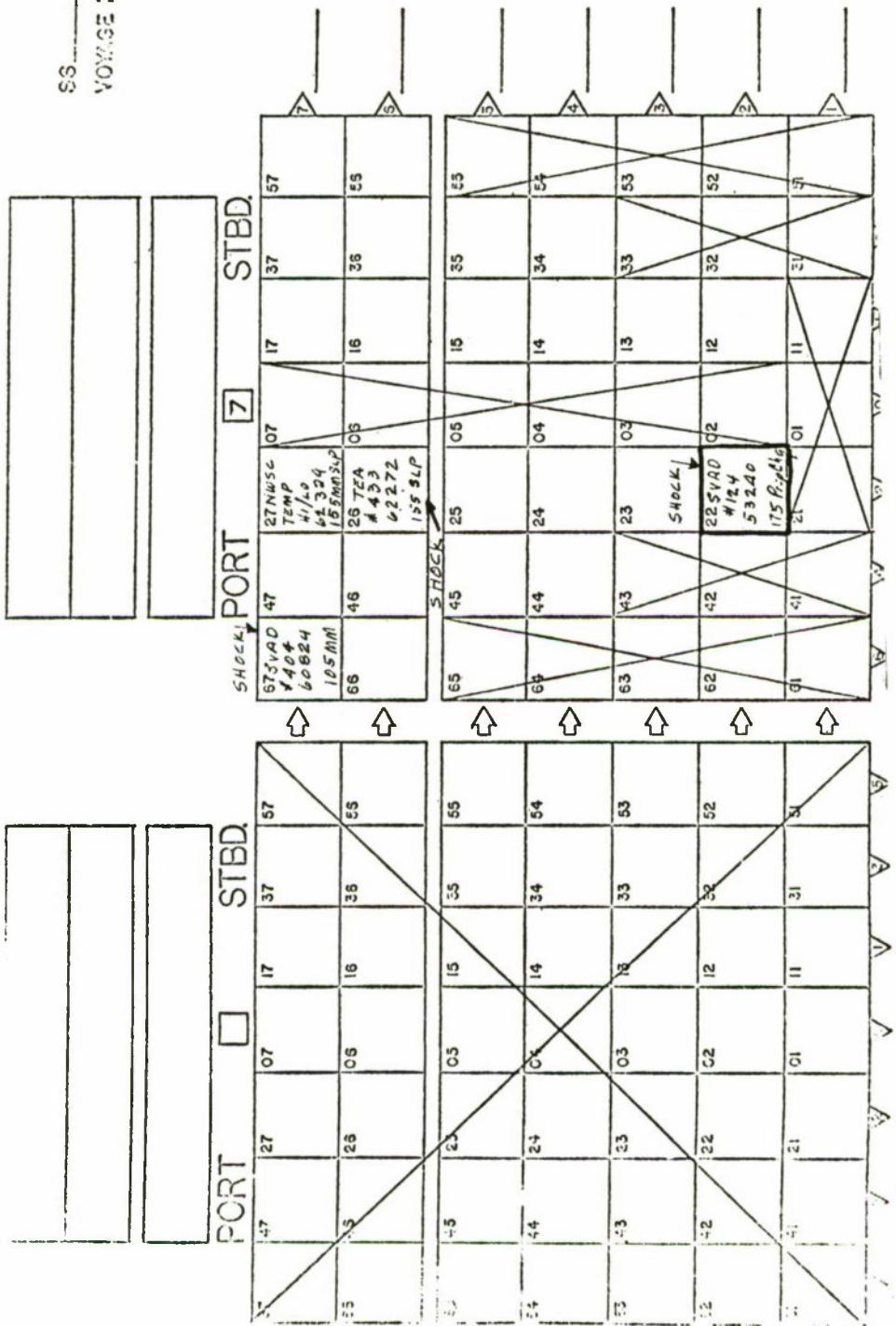


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13. ABSTRACT

The U.S. Army Transportation Engineering Agency (USATEA), Military Traffic Management and Terminal Service, Fort Eustis, Virginia, participated in the development of shipping procedures for eight different types of ammunition which were used in the initial Department of Defense (DOD) test shipment in Sea-Land shipping containers to the Republic of Vietnam (RVN). USATEA's portion of the tests consisted of providing transportation environmental test criteria, participation in the test loadings at Savanna Army Depot, observation of the loading and securing of 2.75-inch rockets and 155-millimeter shells at the Louisiana Army Ammunition Plant, and installation of mechanical shock recorders in two containers to determine shock and vibration environment during the entire move. The movement, originating at Doyline, Louisiana, encompassed highway to Port Chicago, California; terminal handling at Port Chicago; ocean voyage to Cam Ranh Bay, RVN; handling at Cam Ranh Bay; barge move to Qui Nhon; unloading at Qui Nhon; and, finally, the highway move by military convoy to a forward ammunition supply point at Pleiku. Army personnel (USATEA and U.S. Army Materiel Command (USAMC)) inspected the loads at Port Chicago, California, and Cam Ranh Bay and Pleiku, RVN. Good shock and vibration information was obtained covering the entire move, including handling. The shipping procedures proved adequate, and no damage to the cargo was noted.

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	ROLE	WT	ROLE	WT	ROLE	WT
Cargo containers Shock and vibration Shipment of ammunition Shock recorders						

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